

Notes on the generic limits of *Sinosenecio* and *Tephroseris* (Compositae-Senecioneae)

BERTIL NORDENSTAM¹ & PIETER B. PELSER²

¹Department of Phanerogamic Botany
Swedish Museum of Natural History, P. O. Box 50007
SE-10405 Stockholm, Sweden
bertil.nordenstam@nrm.se

²University of Canterbury, Biological Sciences
Private Bag 4800, Christchurch 8140, New Zealand
pieter.pelser@canterbury.ac.nz

Abstract

Based on morphological and molecular evidence three new combinations in the tribe Senecioneae (Compositae) are made, viz., *Sinosenecio changii* (B. NORD.) B. NORD., *Tephroseris koreana* (KOM.) B. NORD. & PELSER, and *Tephroseris newcombei* (GREENE) B. NORD. & PELSER. These transfers leave *Sinosenecio* B. NORD. as a genus restricted to eastern Asia (mainly China, with minor extensions into Myanmar, Thailand, Vietnam) and add to the contents of the circumboreal genus *Tephroseris* in north America.

Introduction

The three genera *Sinosenecio* B. NORD., *Nemosenecio* (KITAM.) B. NORD. and *Tephroseris* (RCHB.) RCHB. have been regarded to form a group within subtribe Tussilaginatae of the tribe Senecioneae and are sometimes even recognized as a separate subtribe Tephroseridinae C. JEFFREY & Y. L. CHEN (1984, CHEN et al., in press). Since the genus *Sinosenecio* B. NORD. was described (NORDENSTAM 1978) the knowledge of the genus has increased considerably mainly thanks to the contributions by C. JEFFREY and Y. L. CHEN (JEFFREY & CHEN 1984, CHEN 1999) and recent in-depth studies by YANG QINER and LIU YING (e.g., LIU 2010, LIU & YANG 2010, 2011a, b, c, d, LIU et al. 2010). A treatment for the Flora of China is in a final stage of preparation, involving several co-authors (CHEN et al., in press).

NORDENSTAM (1978) initially recognized 27 species in the genus *Sinosenecio*, but the revisions by JEFFREY and CHEN recognized 35 species, all native to China,

with small extensions into neighbouring countries. The number of species keeps increasing and the Flora of China treatment now recognizes 41 Chinese species of *Sinosenecio*, all but two of them endemic to China. (CHEN et al., in press).

Somewhat surprisingly, a species from Queen Charlotte Islands in Canada was added to *Sinosenecio* by the transfer of *Senecio newcombei* GREENE (JANOVEC & BARKLEY 1996, cf. also JANOVEC & BARKLEY 2006). JANOVEC & BARKLEY (1996) wrote: "The plant long called *Senecio newcombei* GREENE is a distinctive endemic of the Queen Charlotte Islands, B. C., Canada". These authors realized that the species was not well placed neither in *Senecio*, nor in the aureoid group of *Senecio* now recognized as the genus *Packeria* LÖVE & LÖVE. They argued that it would fit into the East Asiatic (mainly Chinese) genus *Sinosenecio* B. NORD. and made the combination to that effect. The extraordinary biogeographical consequence of this transfer prompted an inquiry by GOLDEN et al. (2001) into the true relationships of *S. newcombei*. They performed a study of molecular sequence data (ITS) and micromorphology (endothelial tissue) of a selection of North American *Tephrosieris* species and two putative representatives of *Sinosenecio* viz. *S. koreanus* (KOM.) B. NORD. and *S. newcombei*. They concluded that *S. newcombei* is closely related to *Tephrosieris*, but the overall relationships remained unresolved and the generic limits between the two genera were not clearly definable because of the limited sampling. A broader study including more taxa of these and related genera was recommended.

JANOVEC & BARKLEY (1996) assigned *S. newcombei* to the tussilaginoïd alliance rather than the senecioid group. This is indicated by micromorphological characters, such as the continuous stigmatic area of the style branches, and the straight and uniform filament collar (not basally thickened). However, the radial (or radial and polar) endothelial tissue of the anthers is an essentially senecioid character. Although some of these characters are found in the Asiatic genus *Sinosenecio*, they are also characteristic of the north circumpolar genus *Tephrosieris*. The chromosome number $n = 24$ in *S. newcombei* (TAYLOR & MULLIGAN 1968) is also prevalent in *Tephrosieris*. As discussed below the basic number $x = 24$ is also reported in *Sinosenecio*, viz. in a substantial group of species which are allied to and perhaps congeneric with *Nemosenecio*. On overall morphological features *S. newcombei* is better positioned in *Tephrosieris* than in *Sinosenecio*. This also makes sense in a biogeographical context. Moreover, molecular data especially from ITS sequences strongly support the inclusion of *S. newcombei* in *Tephrosieris* and disfavour its inclusion in *Sinosenecio* (PELSER et al. 2007, WANG et al. 2009). However, it is not easy to single out any *Tephrosieris* sp. as a close ally to *newcombei*.

In our comprehensive phylogenetic analysis of the tribe Senecioneae we have been able to reconstruct a phylogeny of the tribe and resolve many of the problems

of generic delimitation and circumscription (PELSER et al. 2007, 2010). Although *Nemosenecio* and *Tephroseris* form a well supported clade with a large number of *Sinosenecio* species, at least *Sinosenecio* is not monophyletic as presently defined and further revisions of the generic boundaries in the assemblage are inevitable (WANG et al. 2009, LIU 2010, LIU & YANG 2011a,b, c). The core of *Sinosenecio* including the type species (*S. homogyniphyllus* (CUMM.) B. NORD.) are characterized by a basic chromosome number of $x = 30$ and micromorphological characters such as strictly polarized endothecium, confluent stigmatic area of disc floret styles, and large anthers (LIU & YANG 2011a, b). This group of about a dozen species constitute *Sinosenecio* s. str., which is allied to genera in the subtribe Tussilaginatae such as *Cremanthodium*, *Farfugium*, *Ligularia* and *Parasenecio*. Another assemblage of *Sinosenecio* species have $x = 24$ (or rarely 13), polarized and radial endothecium, divided stigmatic areas, and smaller anthers (LIU & YANG 2011a, b). This group of more than 20 species is more closely allied to *Nemosenecio* (and hence also *Tephroseris*) and may have to be merged with *Nemosenecio* or alternatively separated as a new genus.

Results and Discussion

Sinosenecio is a moderately large genus (>40 species) with a distinct centre in the Sichuan Province of China. In the limited study by GOLDEN et al. (2001) the genus was unfortunately not represented by any typical members, only by *S. koreanus* from north Korea and adjacent part of Jilin in NE China and the North American *S. newcombei*. Both of these taxa belong to the *Tephroseris* clade (PELSER et al. 2007, WANG et al. 2009) and should be removed from *Sinosenecio*. The molecular data firmly place *S. koreanus* with the *Tephroseris* taxa, as also corroborated by the data in GOLDEN et al. (2001). In the more extensive ITS phylogeny of PELSER et al. (2007) *S. koreanus* is grouped with *T. kirilowii* (TURCZ. ex DC.) HOLUB and *T. rufa* (HAND.-MAZZ.) B. NORD. in the *Tephroseris* clade. A similar result was obtained by LIU (2010), who presented a phylogram from an ITS data set, where *S. koreanus* is nested in the *Tephroseris* clade, as sister to a branch consisting of *T. kirilowii*, *T. rufa*, *T. pierotii* (MIQ.) HOLUB and *T. flammaea* (TURCZ. ex DC.) HOLUB. Her analyses based on plastid markers (*ndhC-trnV* and *rpl32trnL*) also clearly identified a well supported *Tephroseris*-*S. koreanus* clade (LIU 2010).

In a previous study mainly based on ITS data (PELSER et al. 2007) we found *Tephroseris* to be sister to a clade composed of *Nemosenecio* and several *Sinosenecio* species. The studied taxa of *Sinosenecio* were all Chinese species centered in the Sichuan Province, viz. *S. septilobus* (CHANG) B. NORD., *S. bodinieri* (VANIOT) B. NORD. and *S. globigerus* (CHANG) B. NORD. The clade also included the problematic *Tephroseris changii* B. NORD., endemic to Sichuan. This taxon

was originally described in *Senecio* and transferred to *Tephroseris* with a new epithet (NORDENSTAM 1978). In some characters it does not conform well to the generic description of *Tephroseris* as discussed by JEFFREY & CHEN (1984), who wrote: "In habit, anther-shape and phyllary number, this species is similar to the scapigerous *Sinosenecio* species and exceptional in *Tephroseris*". The species was accepted in *Tephroseris* with some hesitation by JEFFREY & CHEN (1984), who pointed out that the scapiform stem, number of involucre bracts (13), and anther morphology speak for a position in *Sinosenecio*. Molecular evidence from ITS sequences places the taxon in *Sinosenecio* branch, well supported as distinct from the *Tephroseris* clade (PELSER et al. 2007).

The true relationships of *Tephroseris changii* are in the large group within *Sinosenecio* (sensu lato), characterized by $x = 24$ and related to *Nemosenecio*. In the Flora of China treatment (CHEN et al., in press) this group is still maintained in *Sinosenecio*, and *T. changii* is therefore placed there at least provisionally, although we are aware that this is not its final taxonomic position.

In an extended ITS study of 27 species of the *Nemosenecio-Sinosenecio-Tephroseris* assemblage (WANG et al. 2009), *Tephroseris changii* again grouped with several species of *Sinosenecio*, whereas *S. koreanus* and *S. newcombei* were both firmly placed with *Tephroseris*. We here propose the transfer of these two species to *Tephroseris*, although we are aware that *Sinosenecio* remains polyphyletic and that further generic revisions in the group are inevitable (cf. WANG et al. 2009).

These transfers are to some extent also supported by morphological and cytological data. *S. koreanus* is in overall morphology similar to *Sinosenecio* (LIU & YANG 2011a, b), but molecular data firmly place this taxon in *Tephroseris*. Cytological data (chromosome numbers) confirm the polyphyly of *Sinosenecio* as until recently circumscribed and identify three generic groups, viz. one characterized by $x = 30$ (*Sinosenecio* s. str., including the type, *S. homogyniphyllus*), a second group with $x = 29$ (= monotypic genus *Hainanecio* Y. LIU & Q. E. YANG of subtribe Senecioninae; cf. LIU & YANG 2011c), and a third group with $x = 24$ (rarely 13) (a large group probably to be removed from *Sinosenecio* as a new genus or included in *Nemosenecio*; cf. LIU & YANG 2011b). *S. newcombei* and *S. koreanus* both have $x = 24$, which is congruent with the basic number in *Tephroseris*, where they are now proposed to belong.

1) *Sinosenecio changii* (B. NORD.) B. NORD., comb. nov.

Basionym: *Tephroseris changii* B. NORD., Opera Bot. 44: 44 (1978). – Type: China, Sichuan, W. P. FANG 1145 (N syntype, E, GH, K, P!), W. P. FANG 1180 (PE syntype, E, GH).

Syn.: *Senecio rosuliferus* CHANG, Bull. Fan Mem. Inst. Biol. Bot. 6: 58 (1935), nom. illeg. (non *S. rosulifer* LÉVL. & VANIOT, Feddes Repert. 8: 359, 1910).

2) *Tephroseris koreana* (KOM.) B. NORD. & PELSER, comb. nov.

Basionym: *Senecio koreanus* KOM. in Act. Hort. Petrop. 18: 421 (1901); Fl. Mansh. 3: 710, tab. X (1907). – Type: Korea, near Yalu River, KOMAROV s.n. (LE syntype), near River Segelsu, KOMAROV s.n. (LE syntype), KOMAROV 1601 (K, P, PE).

Syn.: *Sinosenecio koreanus* (KOM.) B. NORD., Opera Bot. 44: 50 (1978).

This taxon has a small distribution area in north Korea and adjacent part of Jilin in NE China, way outside the area of *Sinosenecio*. Its habit is *Sinosenecio*-like with leaf-blades broadly cordate or subtruncate to cuneate but not distinctly palmately veined, and although the petioles are not distinctly winged, they are basally somewhat expanded.

3) *Tephroseris newcombei* (GREENE) B. NORD. & PELSER, comb. nov.

Basionym: *Senecio newcombei* GREENE, Pittonia 3: 249 (1897).

Syn.: *Packera newcombei* (GREENE) W. A. WEBER & Á. LÖVE, Phytologia 49(1): 47 (1981); *Sinosenecio newcombei* (GREENE) JANOVEC & T. M. BARKLEY, NOVON 6: 266 (1996). – Type: Canada, B. C., Queen Charlotte Isl., VI. 1897, NEWCOMBE s.n.(US).

As the cited synonymy reveals, this name has travelled from *Senecio* via *Packera* and *Sinosenecio* to now eventually find its home in *Tephroseris*.

The genus *Tephroseris* with ca. 50 species is mainly Eurasian and not well represented in North America - until now six species including *T. palustris* (L.) RCHB. (as ssp. *congesta*) are known there (BARKLEY & MURRAY 2006). The number of *Tephroseris* species in North America is now increased to seven.

References

- BARKLEY, T.M. & D.F. MURRAY 2006. *Tephroseris* (REICHENBACH) REICHENBACH. In: *Flora of North America North of Mexico*, Vol. 20: 615–618.
- CHEN, Y. L. 1999. *Sinosenecio*. In: CHEN, Y. L. (ed.), *Flora reipublice popularis sinicae* 77(1): 101–141.
- CHEN, Y. L., LIU, Y., YANG, Q. E., NORDENSTAM, B. & C. JEFFREY (in press). *Sinosenecio* B. NORDENSTAM. In: WU, Z.Y., RAVEN, P.H. & D.Y. HONG (eds.), *Flora of China*, Vol. 20–21. Science Press, Beijing; Missouri Bot. Garden, St. Louis.
- GOLDEN, J. L., KIM, Y.D. & J. F. BAIN 2001. A re-evaluation of North American *Tephroseris* and *Sinosenecio* (Asteraceae: Senecioneae) based on molecular and micromorphological data. *Can. J. Bot.* 79: 1195–1201.
- JANOVEC, J. P. & T. M. BARKLEY 1996. *Sinosenecio newcombei* (Asteraceae: Senecioneae): a new combination for a North American plant in an Asiatic genus. *Novon* 6: 265–267.
- JANOVEC, J. P. & T. M. BARKLEY 2006. *Sinosenecio* B. NORDENSTAM. In: *Flora of North America North of Mexico*, Vol. 20: 618–619.
- JEFFREY, C. & Y. L. CHEN 1984. Taxonomic studies on the tribe Senecioneae (Compositae) in eastern Asia. *Kew Bull.* 39: 205–446.
- LIU, Y. 2010. *A Systematic Study of the Genus Sinosenecio* B. NORD. (Compositae). Ph.D. Diss., Inst. Bot., Chinese Academy of Sciences, 277 pp.
- LIU, Y. & Q. E. YANG 2010. *Sinosenecio yilingii* (Asteraceae), a new species from Sichuan, China. *Botanical Studies* 51: 269–275.
- LIU, Y. & Q. E. YANG 2011a. Cytology and its systematic implications in *Sinosenecio* (Senecioneae-Asteraceae) and two closely related genera. *Plant Syst. Evol.* 291: 7–24.
- LIU, Y. & Q. E. YANG 2011b. Floral micromorphology and its systematic implications in the genus *Sinosenecio* (Senecioneae-Asteraceae). *Plant Syst. Evol.* 291: 243–256.
- LIU, Y. & Q. E. YANG 2011c. *Hainanecio*, a new genus of the Senecioneae, Asteraceae, from China. *Botanical Studies* 52: 115–120.
- LIU, Y. & Q. E. YANG 2011d. *Sinosenecio sichuanicus* (Asteraceae), a new species from Sichuan, China. *Botanical Studies* 52: 219–223.

- LIU, Y., ZHANG, D. G. & Q. E. YANG 2010. *Sinosenecio hupingshanensis* (Asteraceae), a new species from Hunan and Hubei, China. *Botanical Studies* 51: 387–394.
- NORDENSTAM, B. 1978. Taxonomic studies in tribe Senecioneae (Compositae). *Opera Bot.* 44: 1–83.
- PELSE, P. B., NORDENSTAM, B., KADEREIT, J. W. & L. E. WATSON 2007. An ITS phylogeny of tribe Senecioneae (Asteraceae) and a new delimitation of *Senecio* L. *Taxon* 56: 1077–1104.
- PELSE, P. B., KENNEDY, A. H., TEPE, E. J., SHIDLER, J. B., NORDENSTAM, B., KADEREIT, J. W. & L. E. WATSON 2010. Patterns and causes of incongruence between plastid and nuclear Senecioneae (Asteraceae) phylogenies. *Amer. J. Bot.* 97: 856–873.
- TAYLOR, R. L. & G. A. MULLIGAN 1968. *Flora of the Queen Charlotte Islands, 2. Cytological aspects of the vascular plants*. Res. Branch, Canad. Dept. Agric., Monogr. 4 part 2.
- WANG, L. Y., PELSE, P. B., NORDENSTAM, B. & J. Q. LIU 2009. Strong incongruence between the ITS phylogeny and generic delimitation in the *Nemosenecio-Sinosenecio-Tephrosieris* assemblage (Asteraceae: Senecioneae). *Botanical Studies* 50: 435–442.